Written Comments provided to the EPA's Clean Air Science Advisory Committee Regarding Aspects of EPA's Draft Integrated Science Assessment and Policy Assessment of the Ozone National Ambient Air Quality Standards

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Introduction

The authors are offering written comments to assist the Environmental Protection Agency's (EPA's) Clean Air Science Advisory Committee (CASAC) in their review of the EPA's 2019 Draft Integrated Science Assessment (ISA) and Policy Assessment (PA) of the Ozone National Ambient Air Quality Standards (NAAQS). Our comments focus on aspects on how EPA used air quality measurements and modeling to evaluate the adequacy of the current ozone primary and secondary NAAQS, as well as the contribution of natural and anthropogenic emission sources and transported ozone within and outside of the United States (U.S.). In these contexts, our review of the ISA and PA resulted in the following general conclusions:

1) The depth of EPA's analysis for the ozone NAAQS review is comparable to previous NAAQS reviews and is adequate for evaluation of the primary ozone standard.

2) In the wake of the D.C. Circuit's August 23, 2019 decision on the adequacy of the 2015 ozone NAAQS and the lack of new information that would substantially change the 2015 findings, the PA's conclusion that the primary standard should be retained is supported.

3) For the secondary standard, we note that the PA, as well as independent technical research, indicates that the current primary standard is protective of the W126 index that is referenced as appropriate for this welfare standard. We also conclude that technical complications with the W126 index that make it difficult to implement are further reasons to rely upon a surrogate metric that is equivalent to the primary standard to address the secondary standard.

4) The ISA and PA documents have reviewed sources of natural and international background ozone. We note that while some components of U.S. background ozone may peak in other seasons, important background ozone contributions are present in summer, and the Asian ozone levels continue to rise.

Adequacy of the EPA Analysis for the Current Ozone NAAQS Review

The scope and depth of EPA's review and use of available monitoring data in conjunction with the application of air quality modeling and factors to evaluate concentrations in a variety of microenvironments to assess personal exposure were used in the development of the ozone NAAQS.

In the development of the 2019 ISA and PA documents, EPA made full use of available measurement data and modeling techniques to evaluate current human inhalation exposure. EPA made appropriate

use of historic and most recent ambient measurements at the time of the evaluation (2015-2017) to thoroughly characterize ground-level ozone concentrations throughout the U.S. This evaluation addressed pertinent aspects, including spatial distribution and trends as well as seasonal and diurnal patterns. In addition to analyzing the NAAQS metric (4th highest daily 8-hour average per year), EPA also examined daily maximum 1-hour average (MDA1) concentrations, and their variation as related to design values for the 2015 ozone standard. This analysis provided elucidation on the regional nature of ozone exposure. In conjunction, EPA evaluated the anthropogenic and natural sources, based on recent measurement and modeling studies, to characterize the influences of anthropogenic and natural sources within and beyond U.S. borders.

The United States Court of Appeals for The District of Columbia Circuit recently confirmed the foundation upon which EPA established the current (2015) form and level of the primary NAAQS.[1] In accordance with that affirmation, we consider it appropriate that in the current PA, EPA enhanced and updated the approach in the exposure and risk assessment[2] that was previously applied in the PA for the 2015 NAAQS using current measurements, models and exposure parameters.

The crux of that assessment is the hypothetical evaluation of exposure and associated risks for eight urban areas that have measured design levels (4th highest eight-hour average per year averaged over three years) corresponding with three NAAQS concentration levels: 65 ppb, 70 ppb (the current NAAQS), and 75 ppb (the 2008 NAAQS). Because ambient ozone is a result of complex photochemical processes acting on emissions of precursors and interacting with a multitude of meteorological variables, there are an infinite number of ways that any specific design concentrations could be achieved. There are also numerous technical challenges in developing plausibly realistic hourly ambient ozone concentrations representing the outdoor environments to which people are exposed. We think that EPA accomplished this goal and here we summarize a few key aspects of EPA's evaluation.

- EPA selected eight urban areas that are geographically distributed throughout the U.S., that vary in altitude and latitude (insolation), coastal and continental environment, types and distributions of anthropogenic sources, and dispersion climatology.

- Measured hourly ambient concentrations over three years were the basis of outdoor exposure. This is more suitable than using modeling in a direct manner because there is no perfect model. Measured values were adjusted by a factor that varied on an hourly basis to achieve the three targeted design values noted above. Rather than applying rollback or other statistical techniques that are unable to account for the complexity of ozone formation, EPA used the state-of-the-science model CAMx to guide the adjustment that accounted for the location of each monitor, time of day and time of year. This was done by developing regression-based parameterizations of how the model responded to area-wide percent reduction in NOx emissions throughout the year. Given that

[1] United States Court of Appeals for The District of Columbia Circuit Argued December 18, 2018 Decided August 23, 2019 No. 15-1385 Murray Energy Corporation, Petitioner v. Environmental Protection Agency, Respondent; American Lung Association, et al., Intervenors. Consolidated with 15-1392, 15-1490, 15-1491, 15-1494 On Petitions for Review of Final Agency Action of the United States Environmental Protection Agency. Available at https://law.justia.com/cases/federal/appellate-courts/cadc/15-1385/15-1385-2019-08-23.html.

[2] National Ambient Air Quality Standards, External Review Draft. Appendix 3C. Air Quality Data Used in Population Exposure and Risk Analyses and Appendix 3D. Exposure and Risk Analysis for the Ozone NAAQS Review.

that the combination of emission sources that could achieve compliance with these levels is open-ended, we deem EPA's method to be suitable as an analysis tool, as ozone formation in nearly all areas of the U.S. is NOx-limited rather than VOC-limited.

- The adjusted hourly concentrations at each monitor were used to map the outdoor exposure concentration at each census tract. EPA chose an objective spatial analysis technique that identifies the nearest monitor in each direction and then weights each monitored value by the inverse square of the distance to the tract. This method results in tract concentrations that are within the range of values of the surrounding monitors. Some other objective methods commonly used to plot data, such as kriging, can produce patterns for which the maxima and minima are not constrained by the monitoring data. However, because in this exercise NAAQS compliance is appropriately determined from monitoring data rather than through modeling, we concur with EPA's method.

- EPA went to great lengths to characterize individual exposure in a variety of microenvironments by applying EPA's Air Pollutant Exposure model, version 5 (APEX). In doing so, EPA has used the latest available information on appropriate concentration adjustments for each microenvironment and activity patterns for the various population sectors in each city.

In summary, given the complexity and degree of uncertainty, we find that EPA's approach to the exposure assessment provides a reasonable objective evaluation of the frequency and range of human exposure to ozone concentrations in the eight urban areas. In conjunction with recent dose-response information, EPA's assessment provides a realistic indication of the potential risks to human health.

Retention of the Current Ozone Primary NAAQS

The August 23, 2019 Federal Court of Appeals for the District of Columbia Circuit decision upheld the ozone standard level of 70 ppb set in 2015. Specifically, the Court ruled that *"EPA reasonably explained its decision to retain the form of the primary standard"*[3] and "*EPA reasonably set the primary standard at 0.07 ppm.* "[4] The court stated that the EPA administrator found that a level of 0.07 ppm would *"protect the large majority of children in the urban study areas (i.e., about 96% to more than 99% of children in individual urban study areas) from experiencing two or more exposures of concern at or above the [0.06 ppm] benchmark."*[5] Thus, the Court regarded that this level of exposure estimated by EPA to be reasonable in setting the 2015 primary standard.

In the 2019 draft PA, EPA presents results of the updated exposure and risk assessment. For a direct comparison with the Court citation regarding children's exposure as noted from the previous assessment, we refer to Table 3-3 of the 2019 draft PA, summarizing the results of the exposure and risk assessment for the eight urban areas just meeting the current 70 ppb NAAQS. This table indicates that 97.1% to more than 99.4% of children in individual urban study areas are protected from experiencing two or more exposures of concern at or above the 0.06 ppm (60 ppb) benchmark. Thus, the current results are consistent with the previous assessment that the Court regarded to be suitable in establishing the ozone NAAQS. This and a multitude of other health effects metrics evaluated in the

[3] Page 15 of the August 23rd ruling.
[4] Page 18 of the August 23rd ruling.
[5] Page 8 of the August 23rd ruling.

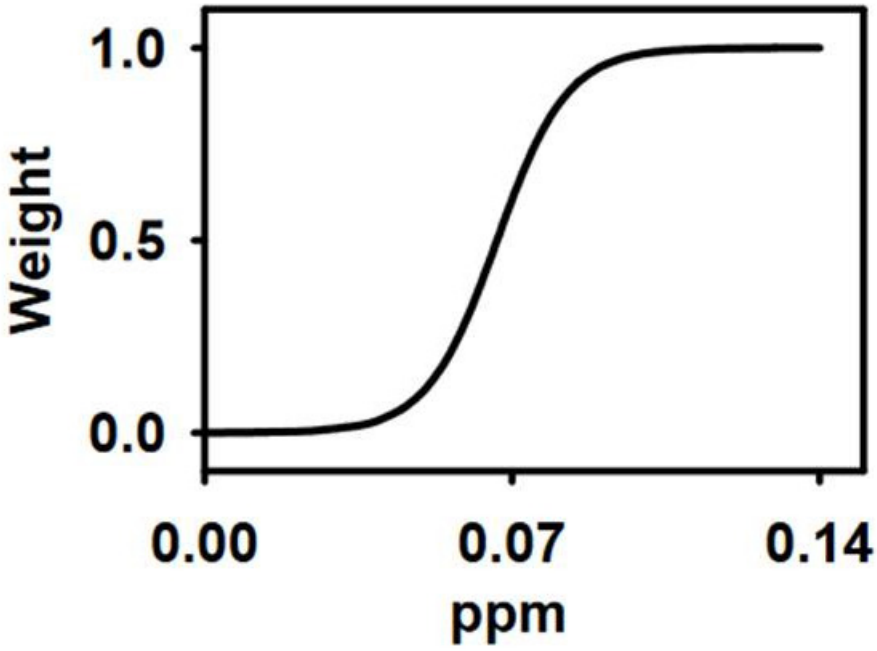
2019 PA confirm that the 70 ppb standard has still been found to be suitably protective, with EPA concluding that, "overall, the newly available quantitative [exposure and risk] analyses appear to comport with the conclusions reached in the last review regarding control expected to be exerted by the current standard on exposures of concern."

Use of the Primary Standard as an Adequate and Feasible Surrogate Metric for the Ozone Secondary Standard

A metric that EPA has considered for the welfare-based secondary ozone standard is referred to as the "W126 index". This index measures the cumulative amount of ozone to which plants are exposed over a single three-month growing season. The discussion below supports the use of the 2015 primary standard as a surrogate for the W126 index.

The W126 value is the sum of weighted hourly concentrations, accumulated over the 12-hour daylight period from 8:00 a.m. to 8:00 p.m., for a consecutive 3-month period within the ozone season with the maximum index value. The graph (Figure 1) below from EPA[6] is helpful to show how this weighting factor in the W126 hourly calculation varies with concentration. Based upon this relationship, it is evident that concentrations at the 2015 primary ozone NAAQS represent a sharp transition between high and low W126 weights, such that a surrogate metric based upon the primary standard seems reasonable, if statistical and modeling data supports this approach.

Figure 1: W126 Weighting for Hourly Ozone Concentrations



Comments submitted to EPA for the 2015 ozone standard proposal included reasons why implementation of the W126 index for the ozone secondary standard would be problematic. For

[6] Web site at https://www.epa.gov/sites/production/files/2015-09/documents/w126_steps_to_calculate_revised_feb19.pdf

example, the Washington Department of Ecology[7] noted the following reasons for considering a surrogate such as the primary standard:

- Software updates would be needed for both photochemical grid modeling and EPA's Air Quality System.
- Procedures for incorporating the W126 metric into New Source Review permitting would need to be worked out.
- More importantly, in the event of an exceedance of a W126 metric, it would be difficult to determine a remedy due to the cumulative nature of the data used in the calculation.
- Handling exceptional events and how they affect the W126 metric would also be complicated.
- States could have areas that attain the primary standard and are nonattainment for the secondary standard. There is no prior experience with nonattainment designations and State Implement Plan requirements for a secondary ozone standard.

The PA concludes that the currently available evidence and quantitative exposure/risk information does not call into question the adequacy of the current secondary standard. In addition, due to the difficult W126 implementation issues, we recommend that CASAC endorse the current primary ozone standard as a surrogate metric for the W126 index to protect the secondary ozone standard, for reasons discussed below.

During the last review of the ozone NAAQS, EPA established a W126 index target of 17 ppm-hrs to address tree growth loss. An August 23, 2019 decision of the D.C. Circuit found that EPA should have applied that target on a single-year averaging time basis, used a lower threshold for a 3-year average, or provided a more thorough explanation for applying the 17 ppm-hr target on a 3-year average basis, based on the record in place for that review. The PA's discussion of leaf foliar injury in Appendix C (Section 4C.6) indicates a small amount of injury for W126 index values at or below 17 ppm-hr. Therefore, assuming a similar approach to that for the 2015 secondary NAAAQS review, one potential next step would be to evaluate whether the form and level of the primary ozone NAAQS at 70 ppb would be protective of a single-year W126 index value of 17 ppm-hr, or a 3-year average of a lower value such as 15 ppm-hr.

Appendix D of the 2019 PA shows, in Figures 4D-4 and 4D-3 (reproduced below as Figures 2 and 3) a scatter plot for the 2015-2017 period of the form of the primary standard (x-axis) versus the 1-year and 3-year averages, respectively, of the W126 index (y-axis) with points colored by region. It is not surprising, based upon Figure 1, that there is a strong relationship between form of the primary ozone standard and the W126 metric. Figure 2 indicates that the current form of the primary ozone NAAQS of 70 ppb is highly protective of the 1-year W126 metric threshold of 17 ppm-hr, with only a few data points above the W126 dashed line corresponding to the 17 ppm-hr threshold[8]. Figure 3 shows that the current form of the primary ozone NAAQS is highly protective of the 3-year average W126 metric threshold of 15 ppm-hr, with only one data points clearly above the W126 blue line corresponding to

[7] Comment to EPA docket EPA-HQ-OAR-2008-0699, available at https://www.ieca-us.com/wp-content/uploads/State-of-WA_Dept-of-Ecology_03.16.15.pdf.

[8] Note that the reporting method for ozone monitoring indicates that hourly averages "shall be reported in parts per million (ppm) to the third decimal place, with additional digits to the right of the third decimal place truncated." Therefore, the lines showing the thresholds in Figures 2 and 3 are slightly higher than the axis-labeled values.

the 15 ppm-hr threshold. Therefore, the PA's Appendix D plots provide support for using the current form of the ozone primary standard as a surrogate for the secondary standard.

Figure 2: Scatterplot of 1-year W126 Index vs. the 3-year Ozone Primary Standard Design Value for 2015-2017 (reproduced from Figure 4D-4 in the PA)

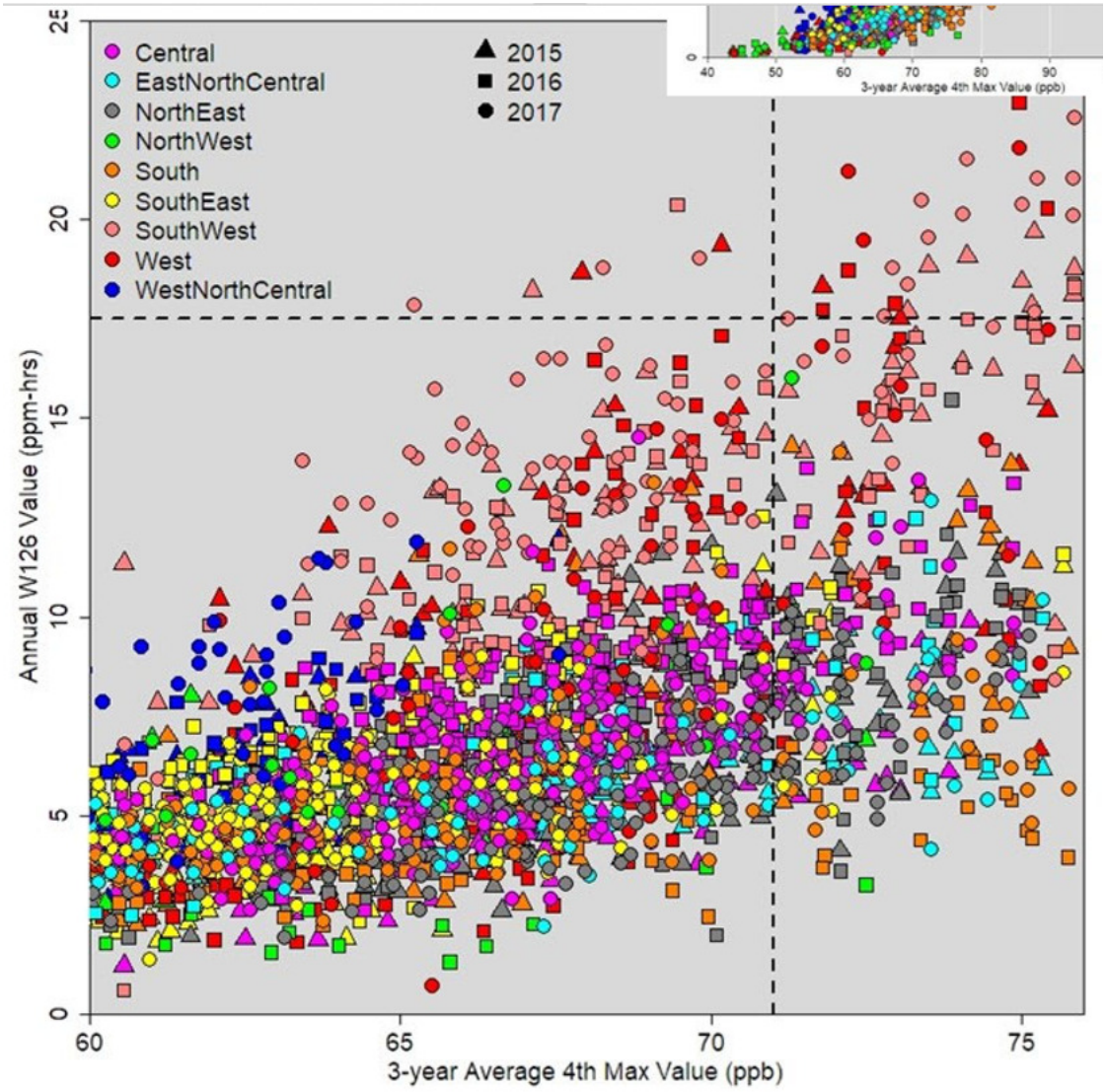
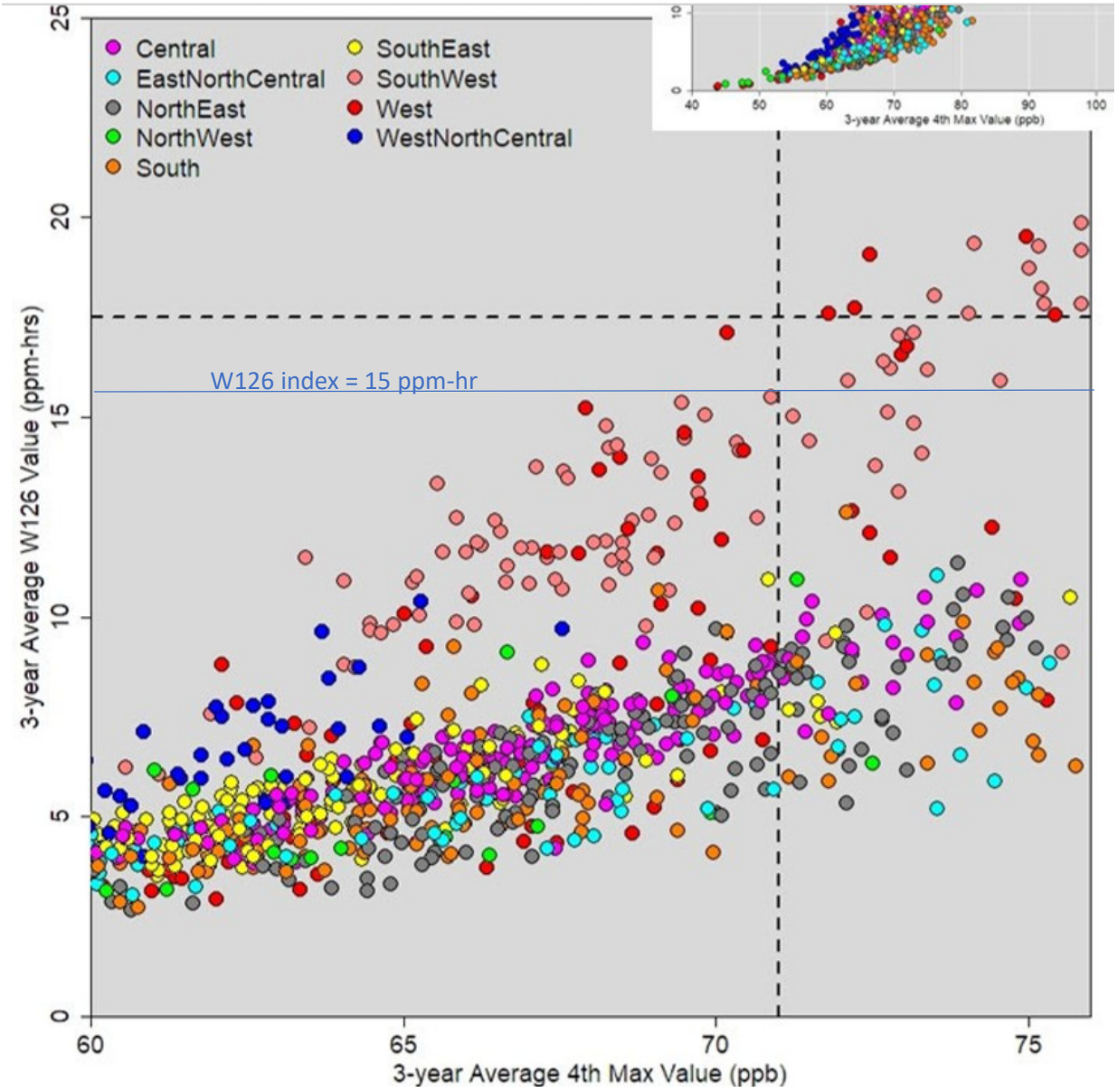


Figure 3: Scatterplot of 3-year W126 Index vs. the 3-year Ozone Primary Standard Design Value for 2015-2017 (reproduced from Figure 4D-3 in the PA)



A CAMx modeling study[9] has reached a similar conclusion, noting that a primary ozone NAAQS of 70 ppb would be protective of a 15 ppm-hr W126 index at a variety of urban and rural sites. The study also noted that if there were separate metrics for the primary and secondary ozone NAAQS, then a remedy would need to consider "a large array of potential emission control pathways to reach air quality goals

[9] Nopmongcol, U., C. Emery, T. Sakulyanontvittaya, J. Jung, E. Knipping, and G. Yarwood, Greg, 2014. A modeling analysis of alternative primary and secondary US ozone standards in urban and rural areas. *Atmospheric Environment*. 99. 266–276. 10.1016/j.atmosenv.2014.09.062. Available at https://www.sciencedirect.com/science/article/pii/S1352231014007559.

that involve local, regional, and national programs, as well as sector-specific regulations. Therefore, the PA's Appendix D plots provide support for using the current form of the ozone primary standard as a surrogate for the secondary standard.

In summary, we encourage CASAC to use available information as noted above to recommend to EPA that the current primary ozone standard can be used as an effective surrogate for the secondary ozone standard.

Aspects of Ozone Background from Natural and International Anthropogenic Sources

Ozone background is referred to as ozone levels that would exist in the absence of anthropogenic emissions within a particular area. For the United States, background (sources of ozone that cannot be regulated by the United States) is generally categorized as that due to:

1) natural sources such as stratospheric intrusions, wildfires, lightning, etc.

2) "nearby" international anthropogenic sources (Mexico and Canada) that can have high ozone impacts close to the border and

3) other international sources, especially from Asia that have more widespread, but often with lower peak impacts than those sometimes experienced near the U.S. / Canada and U.S. / Mexico borders.

An understanding of background levels and trends is important for understanding the ozone levels that would remain if all U.S. anthropogenic ozone precursor emissions were eliminated. Background levels are useful for understanding challenges present for attaining NAAQS levels. Appendix 1 of the ISA and Section 2.5 of the PA contain discussions of ozone background issues.

The ISA notes that ozone production from wildfires can range from a few ppb to up to 30 ppb. It is noteworthy that wildfire season[10] starts after snowmelt and with increased temperatures of summer, accompanied by initiation with lightning strikes. This component of background often peaks during the same season (summer) as peak photochemical activity involving anthropogenic emissions. A related background production of an ozone precursor, oxides of nitrogen, is due to lightning activity which also peaks in summer.

The ISA has a discussion of stratospheric intrusions ("SIs") of ozone in Section 1.3.2 of Appendix 1. Although the ISA indicates that Sis are most common in the spring at high altitudes in the western United States, there are also occurrences[11] of SIs in the eastern US and during the summer. Due to the presence of ozonesondes (instruments that provide vertical atmospheric sampling of ozone concentrations) and aircraft ozone measurements during a research study (the 2011 DISCOVER AQ campaign), the presence of these SIs was able to be detected. These (and other) summertime SIs likely did not immediately transport ozone to ground level, but the ozone transported to the troposphere was

[10] Wildfire seasonal trends are discussed by A. Westerling, 2016. Increasing western US forest wildfire activity: sensitivity to changes in the timing of spring. *Philos Trans R Soc Lond B Biol Sci.* 371(1696): 20150178. doi: 10.1098/rstb.2015.0178 (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4874415/).

[11] Ott, L. E., et al. 2016. Frequency and impact of summertime stratospheric intrusions over Maryland during DISCOVER-AQ (2011): New evidence from NASA's GEOS-5 simulations, *J. Geophys. Res. Atmos*., 121, 3687–3706, doi:10.1002/2015JD024052. https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1002/2015JD024052.

then available for mixing to the ground on subsequent days when the enhanced contribution could potentially contribute to NAAQS exceedances. It is possible that summertime SIs are much more prevalent than previously thought, but their detection requires additional observations that are not routinely made or available at this time.

Anthropogenic sources of ozone and ozone precursors in the border countries of Mexico and Canada will provide their peak impacts, generally on border areas in the U.S., during the ozone season. More distant impacts of background ozone are likely to be more important from Mexico rather than Canada due to the southerly wind component with flow from Mexico to the U.S., likely associated with atmospheric conditions that are more favorable to ozone production, that can combine the higher background levels to ozone from U.S. anthropogenic sources.

The other category of international background ozone is contributions from outside the U.S., Mexico, and Canada. An important source region is Asia, especially from China and India. Transport of ozone from Asia is likely to affect the United States during the ozone season months in spring and early summer[12] due to seasonal variability in hemisphere-scale circulation patterns.

Although the ISA states in Appendix 1 that reductions in NOx emissions in China is leading to lower ozone concentrations from that important geographic region, recent evidence indicates that this is not the case. Ozone concentrations continue to increase in China (see, for example, Beijing ozone concentration trends in Figure 4) due to an important role played by particulate matter in the chemistry of the ozone formation. In China, reduction of particulate emissions in recent years has led to increases in ozone concentrations in spite of NOx emission reductions because the aerosol sink of hydroperoxy (HO2) radicals has been reduced[13], which, in concert with additional sunlight, has stimulated ozone production.

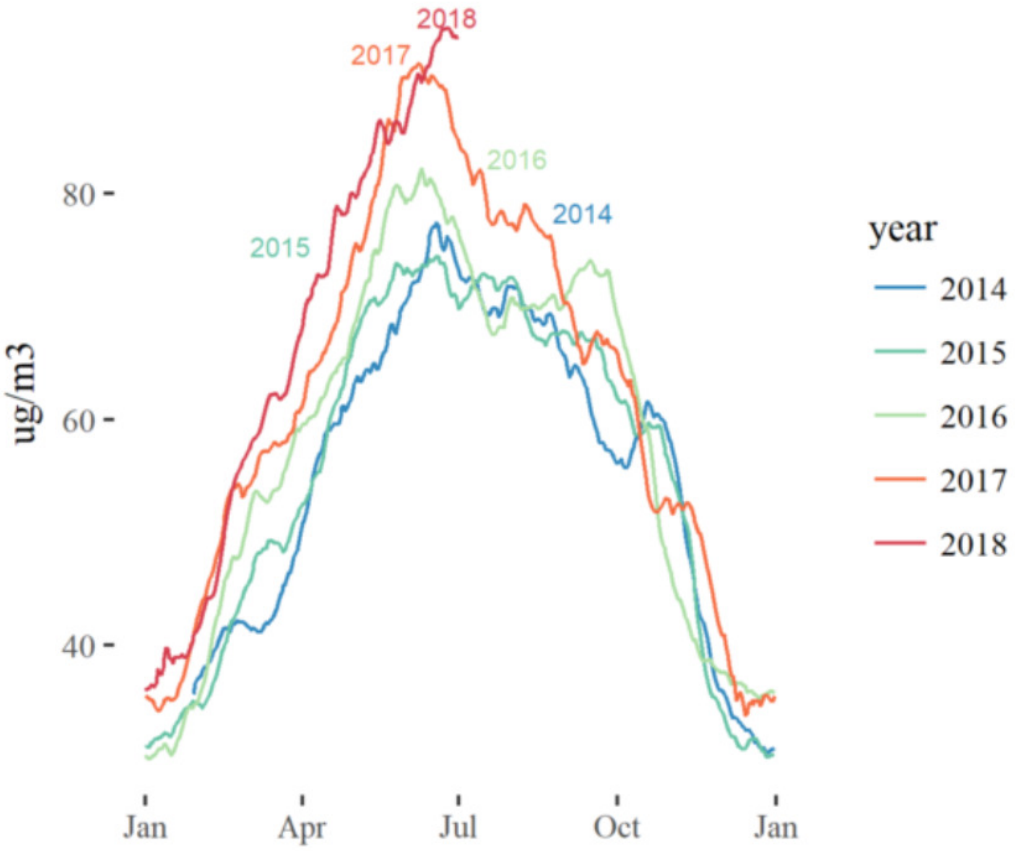
In summary, we note that the ISA and the PA indicate that while U.S. anthropogenic ozone peaks in the summer, U.S. background ozone will often peak in other seasons (e.g., spring for stratospheric intrusions). However, we point out from recent research cited above that during the summer season, background ozone contributions are still present, even if not at their peak:

- Stratospheric intrusions can occur during the summer in all areas of the United States, and the ozone available in the troposphere can mix to the ground on subsequent days.
- Wildfire and lightning contributions to ozone occur in the summer months.
- The Canada and Mexico ozone contributions are expected to be high during the summer months.
- The ozone concentrations in China are actually increasing, while the ISA indicates that this contribution to background levels may actually be on the decline, “probably due to decreasing East Asian precursor emissions.” Monitoring data show that China ozone levels are not declining and that theypeak in early summer, and therefore can contribute to the total U.S. ozone readings during the early portion of the U.S. ozone season.

[12] Congressional Research Service, 2019. Background Ozone: Challenges in Science and Policy. Available at https://fas.org/sgp/crs/misc/R45482.pdf.

[13] Li , K., D. Jacob, H. Liao, L. Shen, Q. Zhang, and K. Bates. 2019. Anthropogenic drivers of 2013-2017 trends in summer surface ozone in China. *Proceedings of the National Academy of Sciences.* 116. 10.1073/pnas.1812168116.

Figure 4: 30-day Running Averages of Beijing Ozone Monitored Concentrations[14]



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[14] Source: https://unearthed.greenpeace.org/2018/07/18/china-ozone-air-pollution-is-getting-really-bad/.